GROUP 11A

ENGINE MECHANICAL <4A9>

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GENERAL INFORMATION

M2112000100697

The newly developed 1.5L 4A91 engine features 4-cylinder, 16-valve, and double overhead camshafts (DOHC).

The engine has the following features.

- Aluminum cylinder block
- MIVEC (Mitsubishi Innovative Valve timing Electronic Control system)
- Selective valve tappet of direct acting valve system for valve clearance adjustment
- Timing chain

MAJOR SPECIFICATIONS

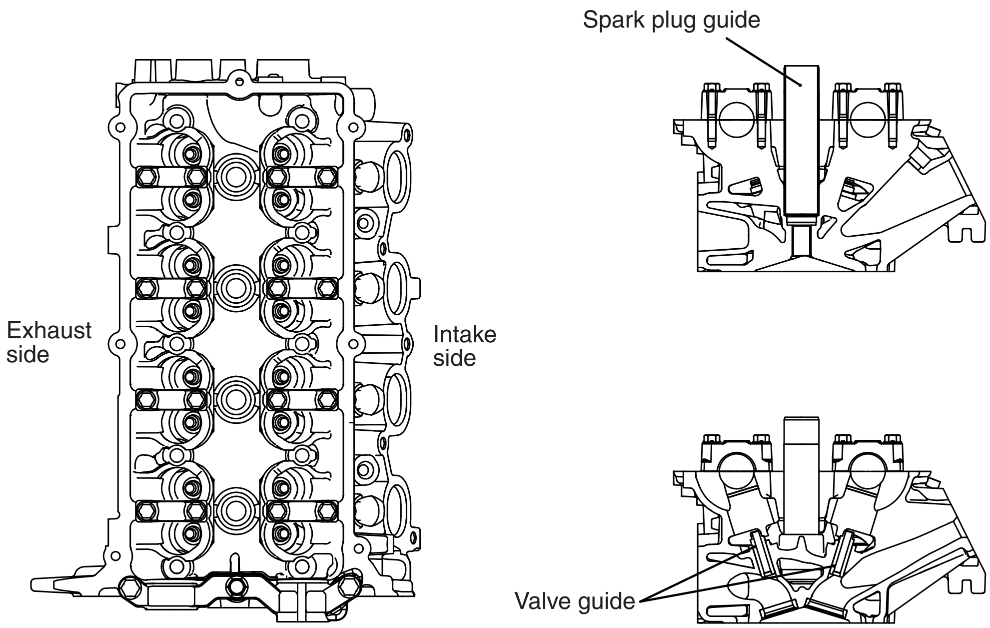
Item		**4A91**
Total displacement mL		1,499
Bore × Stroke mm		75 × 84.8
Compression ratio		10.0
Compression chamber		Pentroof-type
Valve timing	Intake opening	BTDC 31° – ATDC 19°
	Intake closing	ABDC 21° – ABDC 71°
	Exhaust opening	BBDC 39°
	Exhaust closing	ATDC 5°
Maximum output kW (PS)/rpm		77 (104)/6,000
Maximum torque N·m (kg·m)/rpm		141 (14.4)/4,000
Fuel system		Electronically controlled multipoint fuel injection
Ignition system		Electronic-controlled 4-coil

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BASE ENGINE

M2112001000864

CYLINDER HEAD

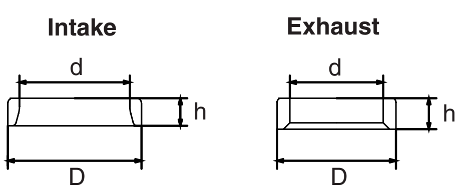


AK305050AB

The cylinder head is made of aluminum alloy, which is lightweight and has an excellent cooling efficiency. The pentroof type combustion chamber has a spark plug in the center. The valve angle is relatively small, contributing to size reduction.
The intake and exhaust ports are arranged in a cross-flow construction. Each cylinder has a pair of intake ports on one side and a pair of exhaust ports on the other side.

Each of the intake and exhaust camshafts is supported by 5 bearings. On each camshaft, the thrust load is supported by No. 1 bearing. The No. 1 bearings for the intake and exhaust camshafts have a common bearing cap.

VALVE SEAT



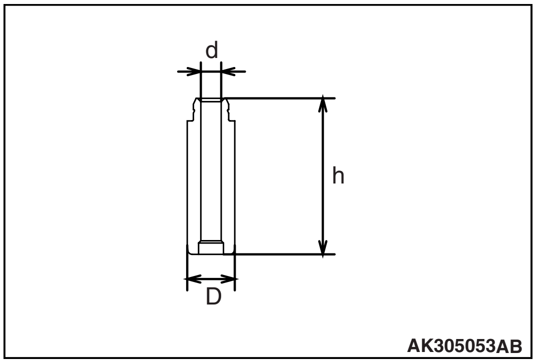
AK305052AB

Sintered alloy valve seat

Item	Intake	Exhaust
D (Outer diameter) mm	31.5	28
d (Inner diameter) mm	26	22
h (height) mm	6.6	7.3

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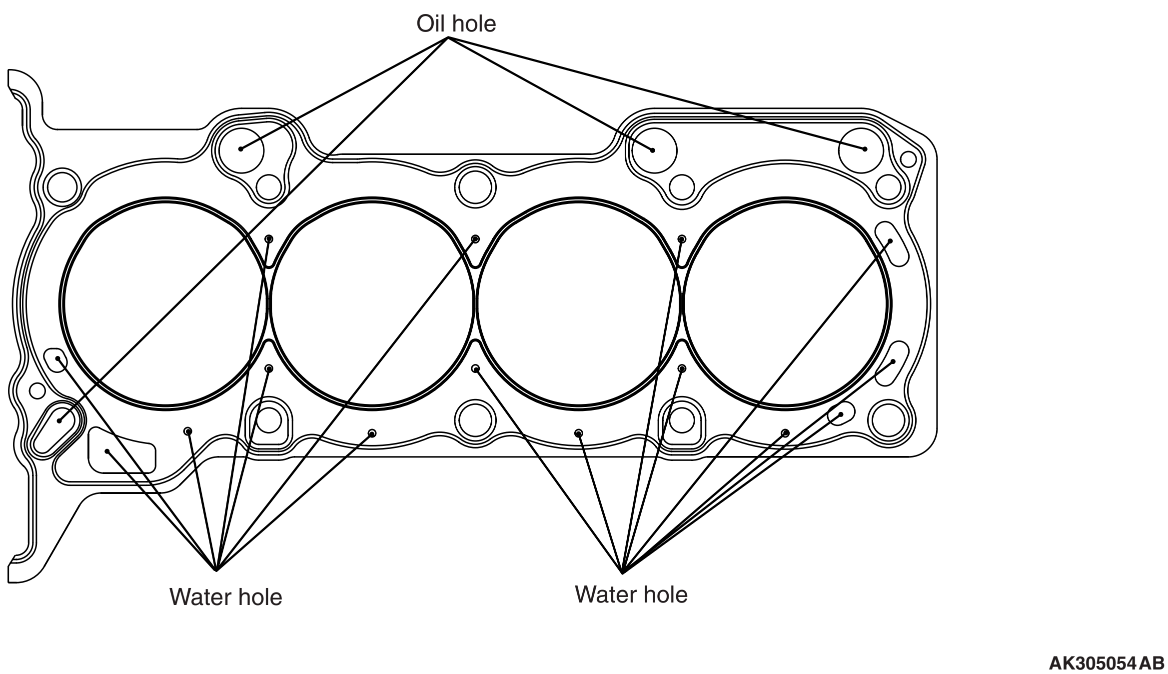
VALVE GUIDE



The intake and exhaust valves use the same-design valve guide.

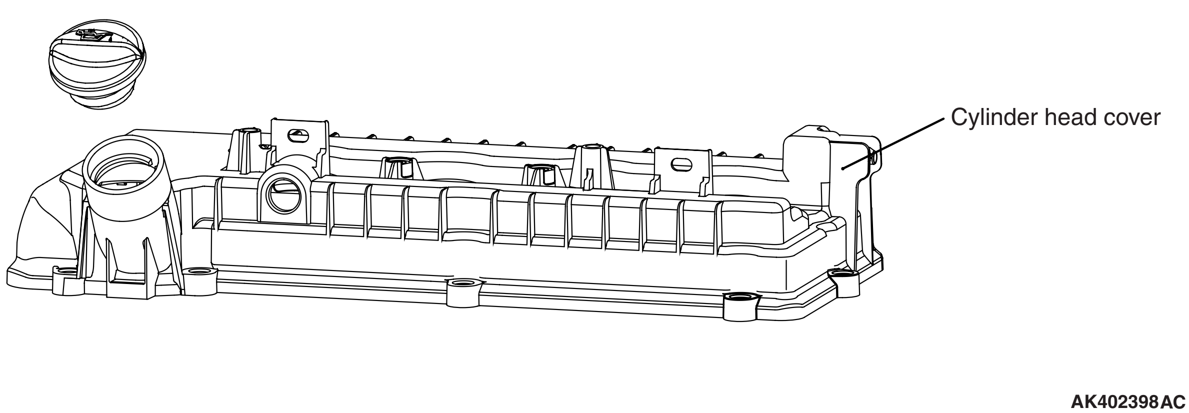
Item	Intake
D (Outer diameter) mm	10.5
d (Inner diameter) mm	4.5
h (height) mm	34.5

CYLINDER HEAD GASKET



The metal gasket having heat resistance, sealability and low cost is used for the cylinder head gasket.

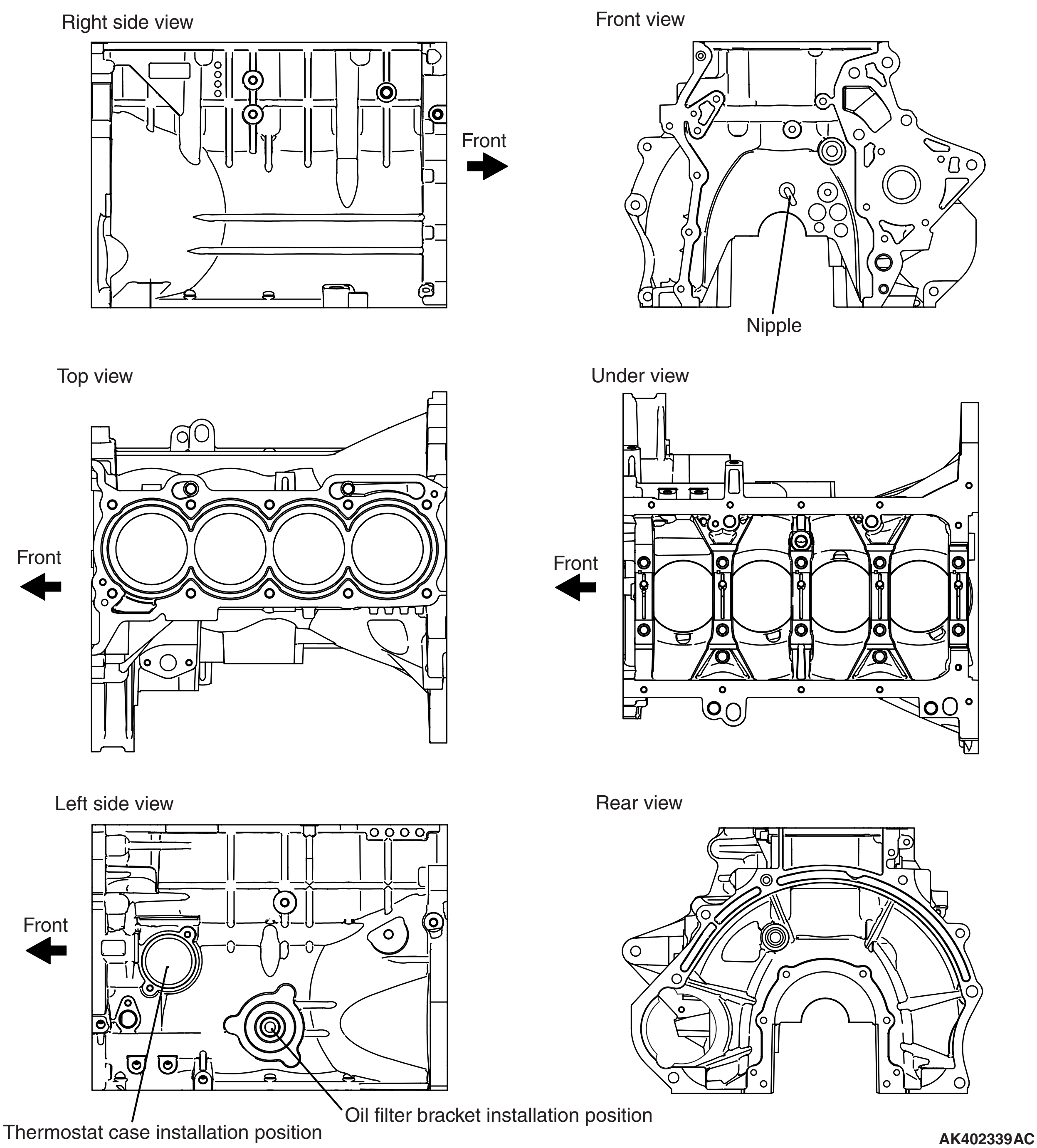
CYLINDER HEAD COVER



A resin cylinder head cover is used for the cylinder head.

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CYLINDER BLOCK

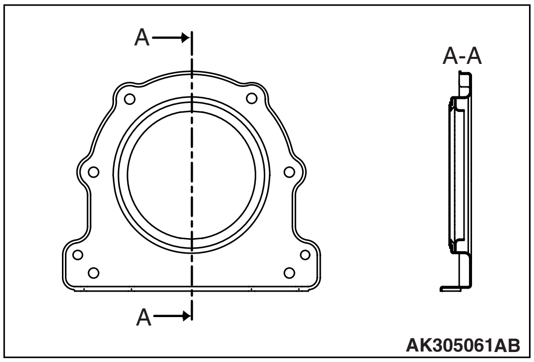


The cylinder block is made of lightweight aluminum alloy.
The crankshaft journal is supported by 5 bearings.
The crankshaft thrust load is supported by No. 4 bearing.
The water jacket is of a full-siamese design.
A nipple is provided at the front of the block to supply engine oil onto the timing chain.

Item	Dimension
Overall height mm	280
Overall length mm	375.1
Top face to crankshaft center mm	205
Crankshaft center to bottom face mm	75
Bore mm	75
Bore pitch mm	83
Stroke mm	84.8

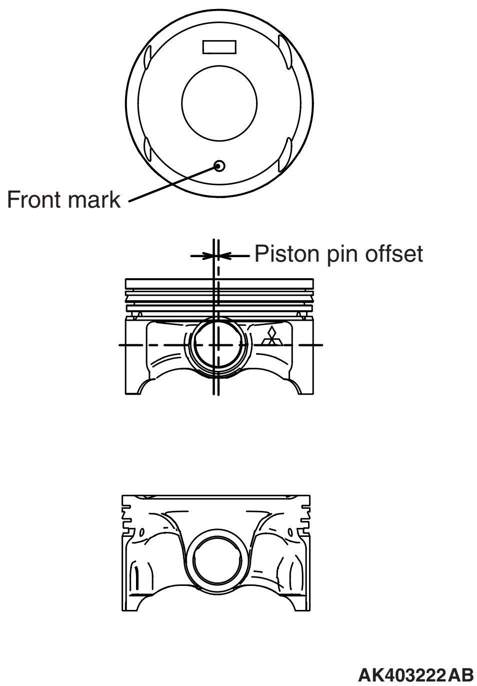
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REAR OIL SEAL CASE



The rear oil seal case is a sheet-metal work. The case is installed with sealant applied onto the mounting face to prevent oil leakage.

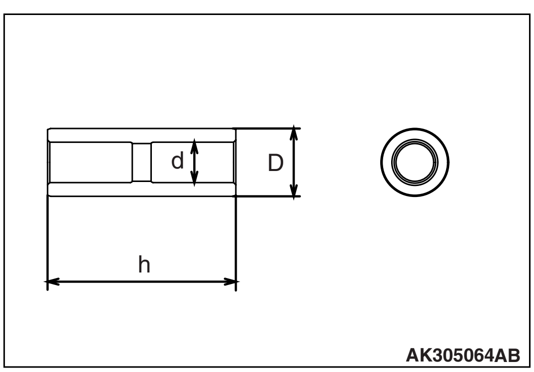
PISTON



The piston is made of special aluminum alloy. Weight reduction is achieved by minimizing the overall height while maximizing the recess on both ends of the piston pin.
The center of the piston pin hole is offset by 0.5 mm from the center of the piston towards the thrust side.
The piston skirt has a streak finish to enhance oil retention and anti-seizing property.

Item	Dimension
Base diameter mm	75
Pin diameter mm	18
Overall height mm	46.04

PISTON PIN

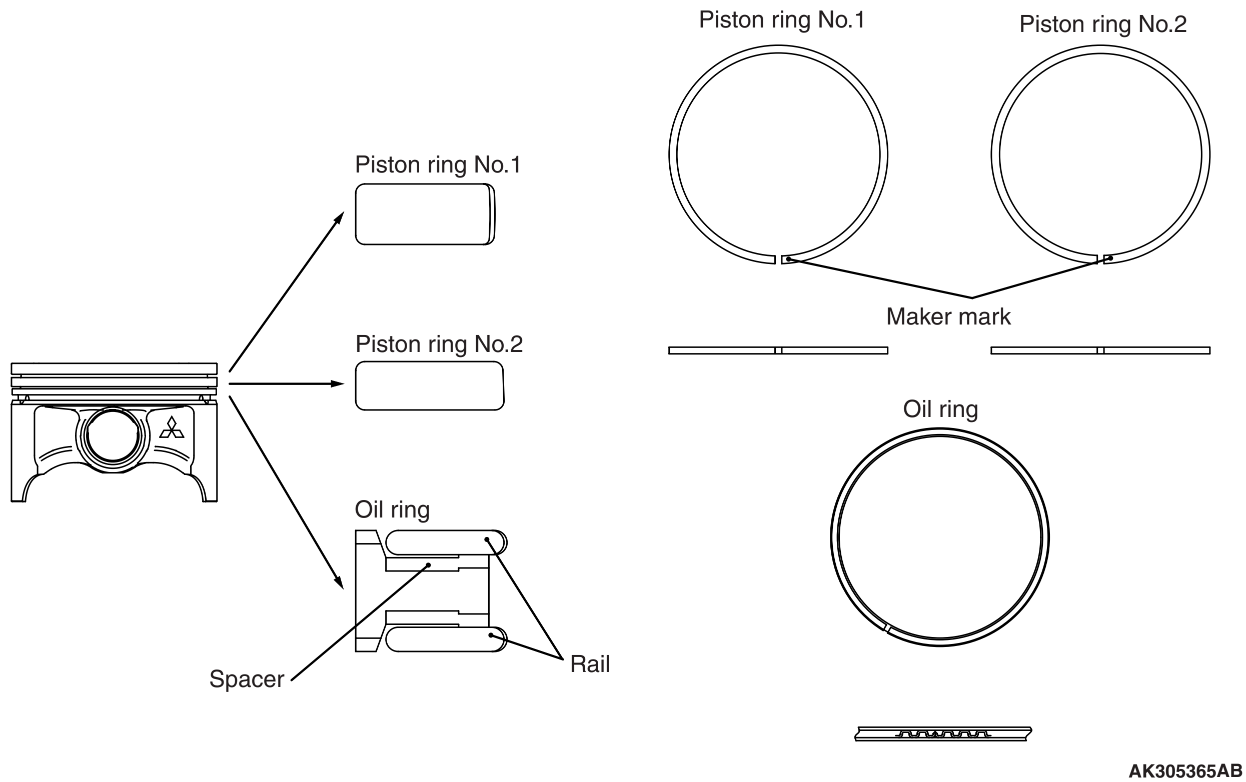


The piston pin is of a semi-floating type, press-fitted into the connecting rod small end while capable of floating relative to the piston.

Item	Dimension
D (Outer diameter) mm	18
d (Inner diameter) mm	11
h (Overall length) mm	50

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PISTON RING

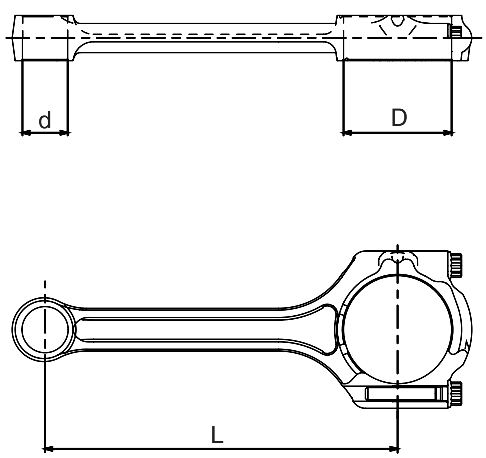


Each piston is provided with No. 1 and No. 2 compression rings and an oil ring.

Item	No. 1 piston ring	No. 2 piston ring	Oil ring
Shape	Barrel	Undercut	3-piece
Surface treatment (Contact face with cylinder)	Ion plating	Parkerized	Ion plating
Maker mark	No mafking	2R	No marking

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CONNECTING ROD

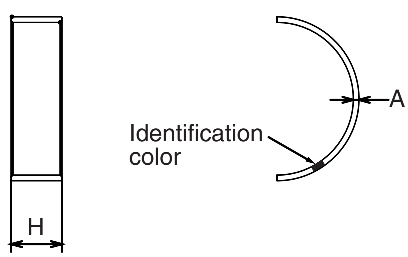


AK305065AB

The connecting rod is made of highly rigid, forged carbon steel. The rod portion has an H-shaped cross section.
The connecting rod big end bearing is lubricated through an oil passage running from the main journal to the crankshaft pin.

Item	Dimension
d (Small end inner diameter) mm	18
D (Large end inner diameter) mm	43
L (Center distance) mm	135.6

CONNECTING ROD BEARING



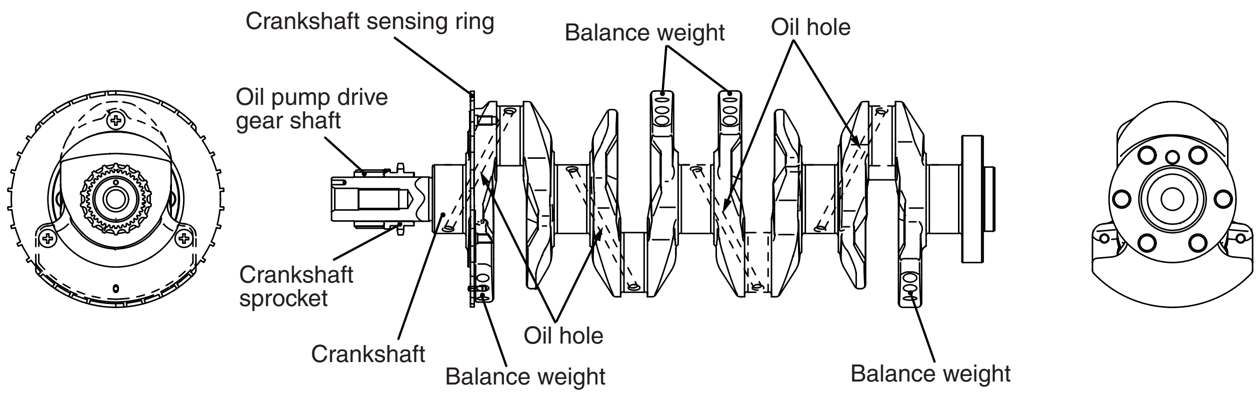
AK305309AB

The upper and lower connecting rod bearing halves are identical.
The connecting rod bearing is equipped with back metal. While the bearing itself is made of aluminum alloy, the back metal is normally made of steel sheet.
The connecting rod bearing is narrower than the bearing cap, this is to minimize wear.

Item	Dimension
H (Width) mm	13.5
A (Thickness) mm	1.5

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CRANKSHAFT

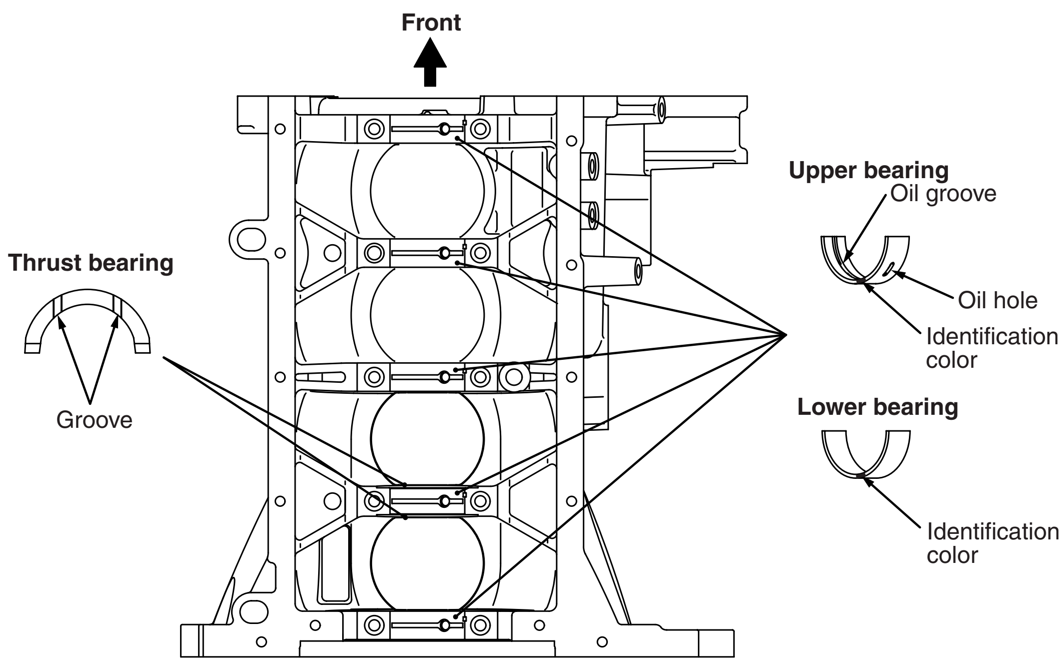


AK305068AD

A casted crankshaft is used for the crankshaft.
The crankshaft consists of 5 main bearings and 8 balance weights.
The crankshaft pins are arranged at 180° intervals.
The oil hole supply lubrication oil from the journal to the crank pin.

A crankshaft sprocket and an oil pump drive gear shaft are press-fitted onto the front of the crankshaft. The crankshaft is also fitted with a crankshaft sensing ring.

CRANKSHAFT BEARING, THRUST BEARING



AK305070AB

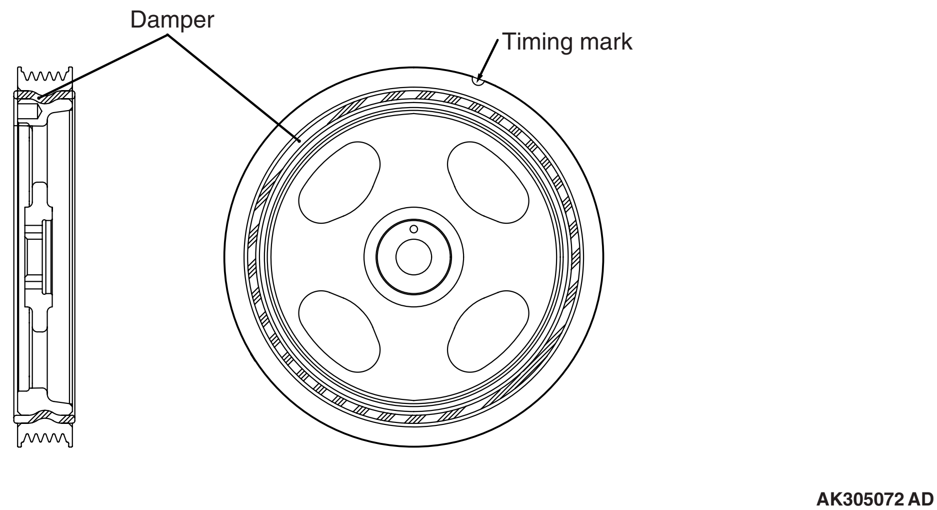
The upper crankshaft bearing (with oil groove) is located on the cylinder block side while the lower bearing (without oil groove) is held by the bearing cap.
The crankshaft bearing is equipped with back metal. While the bearing itself is made of aluminum alloy, the back metal is normally made of steel sheet.

A thrust bearing is installed on both sides of the No. 4 crankshaft bearing.

Item		Dimension
Crankshaft bearing	Width mm	16
	Thickness mm	20
Crankshaft thrust bearing	Thickness mm	3.275

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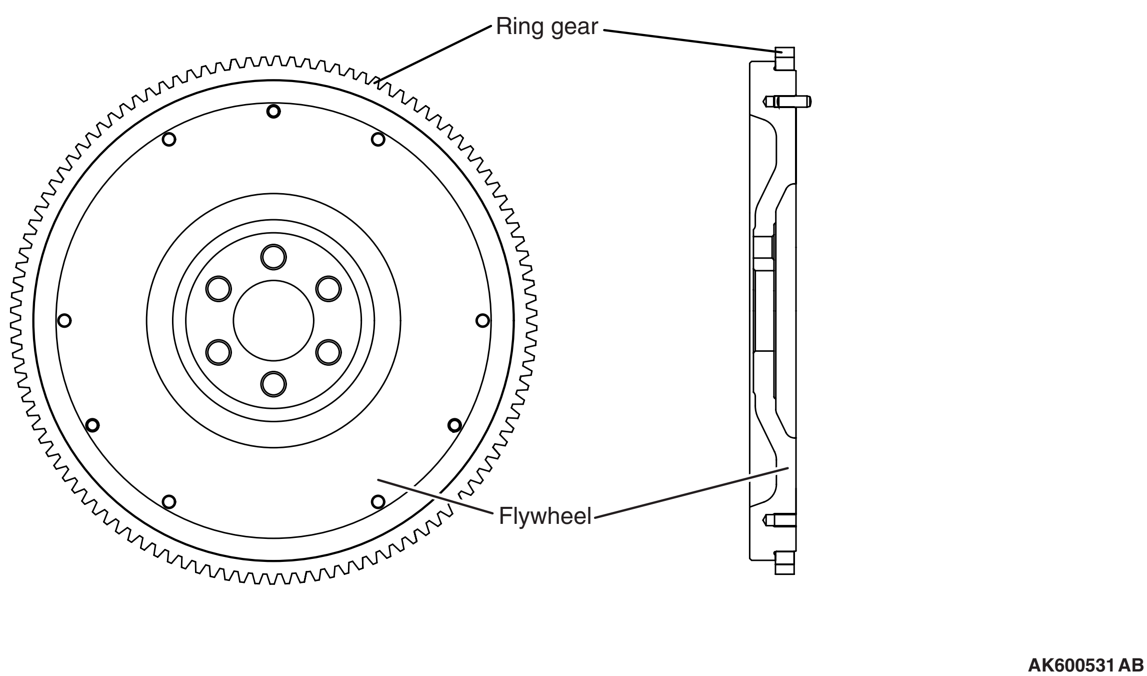
CRANKSHAFT PULLEY



A cast iron crankshaft pulley is used.
The pulley has grooves to engage with a V-ribbed belt (5 ribs), which drives an alternator and a water pump.
An ignition timing mark (notch) is stamped on the flange of the pulley.

The crankshaft pulley is equipped with a torsional damper to minimize the torsional vibration of the crankshaft as well as substantially reduce noise and vibration at the high speed range.

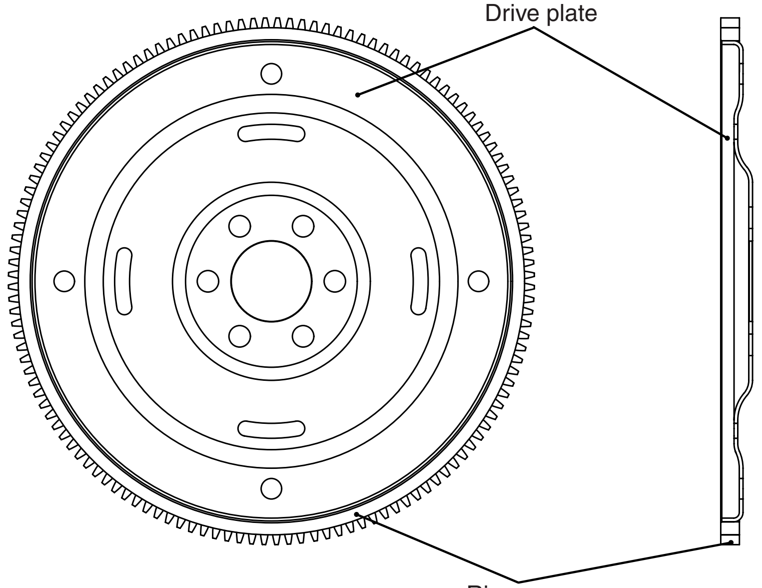
Flywheel



A cast iron ring gear is a shrink fit in the iron casting of the flywheel. The flywheel is installed by tightening six bolts.

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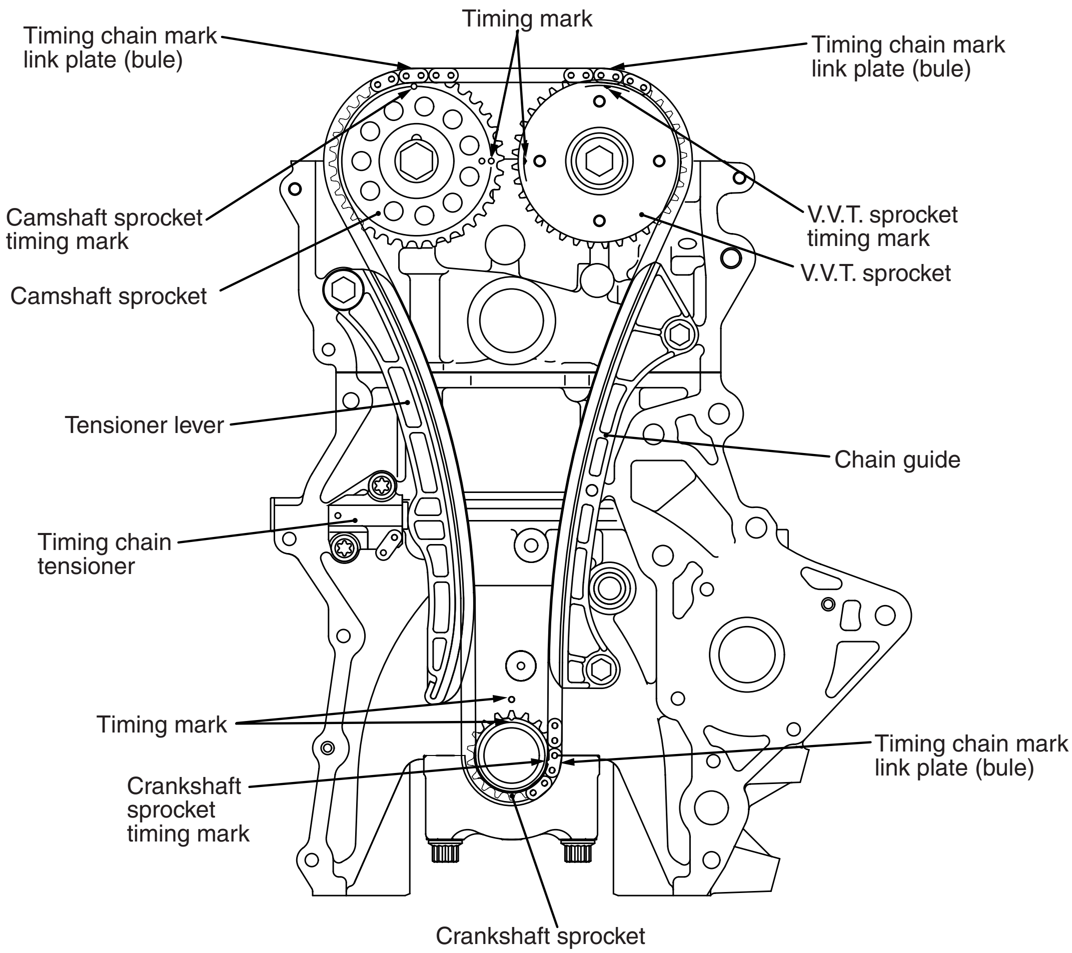
DRIVE PLATE



A cast iron ring gear is a shrink fit in the steel plate of the drive plate. The drive plate is installed by tightening six bolts.

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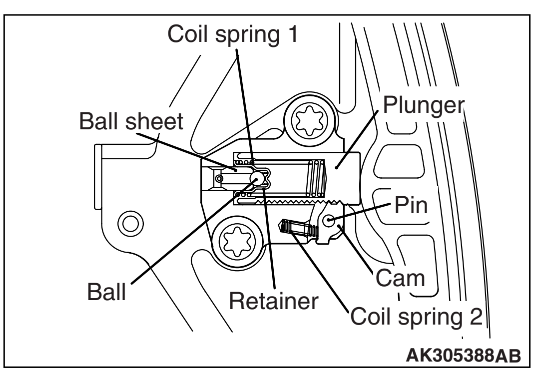
TIMING CHAIN TRAIN



The 2 camshafts are driven by the timing chain via the respective sprockets.
The timing chain, consisting of 122 links, is an endless chain, connecting the crankshaft sprocket with the camshaft and V.V.T. sprockets.
The timing chain is equipped with 3 mark link plates (blue) to correctly time the 3 sprockets with each other.

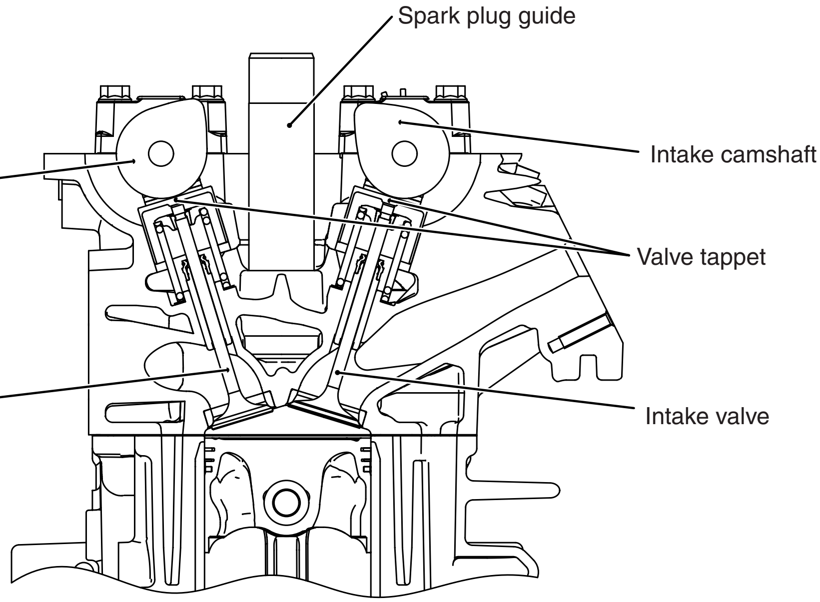
Item	No. of teeth
Camshaft sprocket	36
V.V.T. sprocket	36
Crankshaft sprocket	18

TIMING CHAIN TENSIONER



The timing chain is tensioned by the timing chain tensioner, which has a built-in plunger with plunger springs.
The plunger in the timing chain tensioner directly pushes the tension lever, and the pressure automatically adjusts the timing chain tension.
A cam is provided to lock the plunger in place after the engine stops. This helps prevent the timing chain from wobbling just after the engine starts.
With the timing chain tensioner installed, do not crank the engine in the reverse direction. This will force the plunger to overcome the cam, or even cause other problems.

VALVE MECHANISM

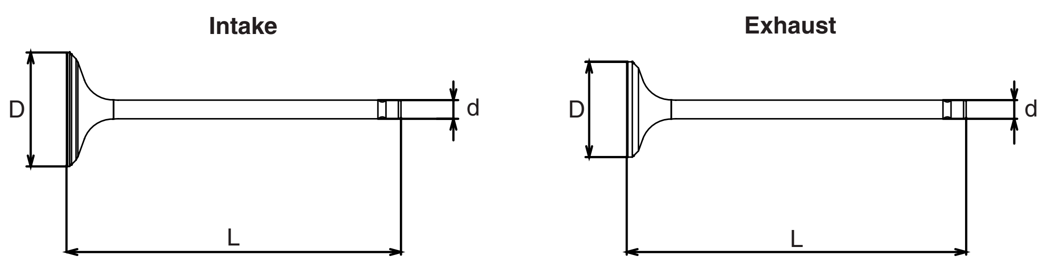


AK305076AB

The valve mechanism is based on a 4-valve DOHC (Double Over Head Camshaft) design having the camshaft on the upper valve. Each cylinder has 2 intake valves and 2 exhaust valves, arranged in a V-shape pattern.

Camshaft rotation is transmitted via valve tappets to the respective valves which open and close accordingly.

VALVE



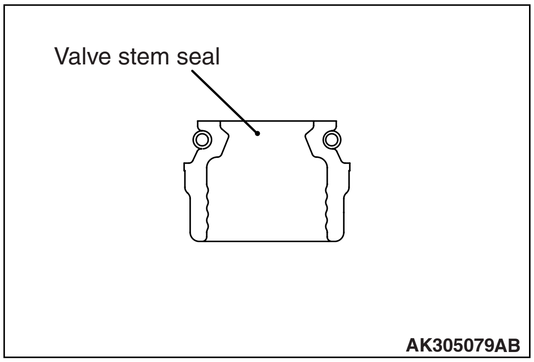
AK305078AB

The valves have heat-resistance. The entire valve surface is treated with gas nitriding.

Item	Intake valve	Exhaust valve
Head diameter mm	30.5	25.5
Stem diameter mm	5.0	5.0
Overall length mm	89.61	90.94

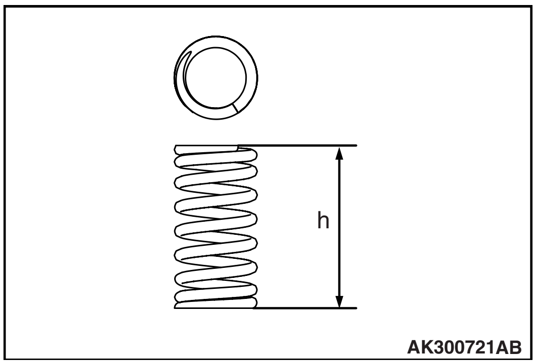
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VALVE STEM SEAL



The valve stem seal employs springs to enhance sealing performance, minimizing oil passing down to the port.

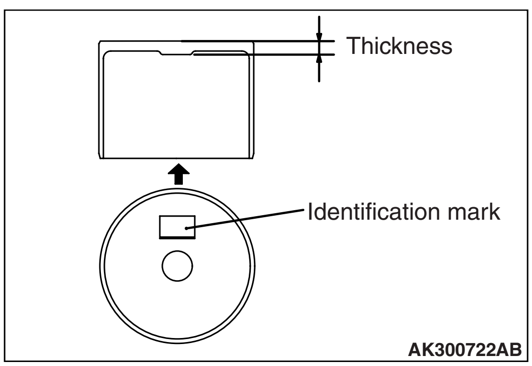
VALVE SPRING



The valve spring has a dual pitch spring to prevent surging in the high speed range.

Item	Specification
Free length mm	43.1
No. of spring turns	8.49

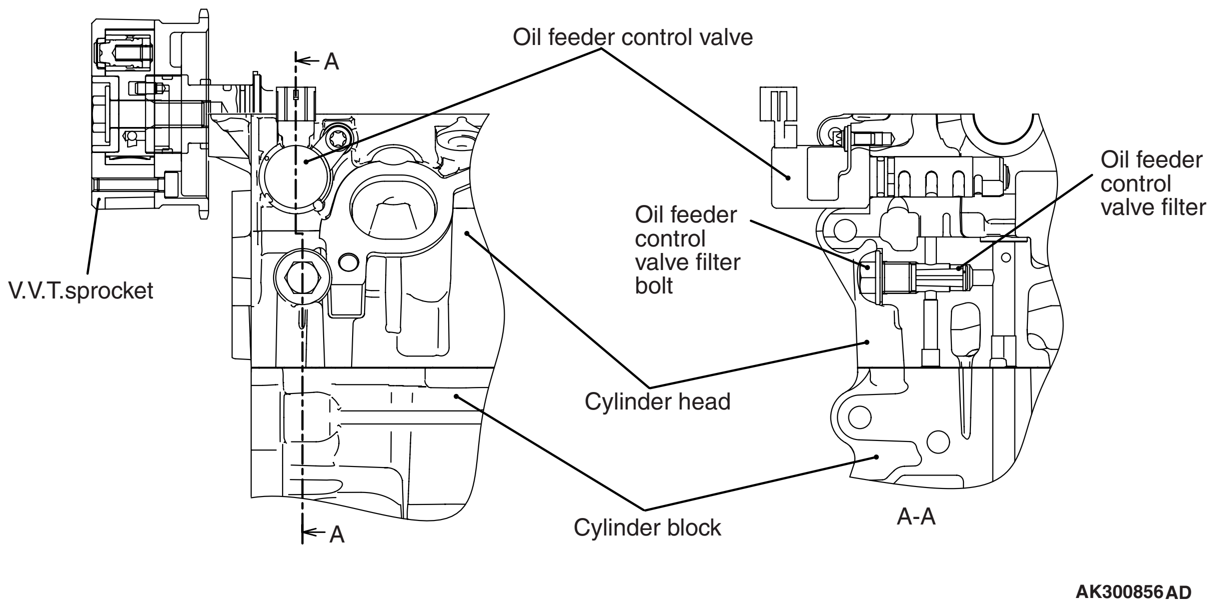
VALVE TAPPET



Valve tappets are available in 31 thicknesses, at 0.02 mm intervals between 2.70 mm and 3.30 mm, to ensure correct valve clearance.

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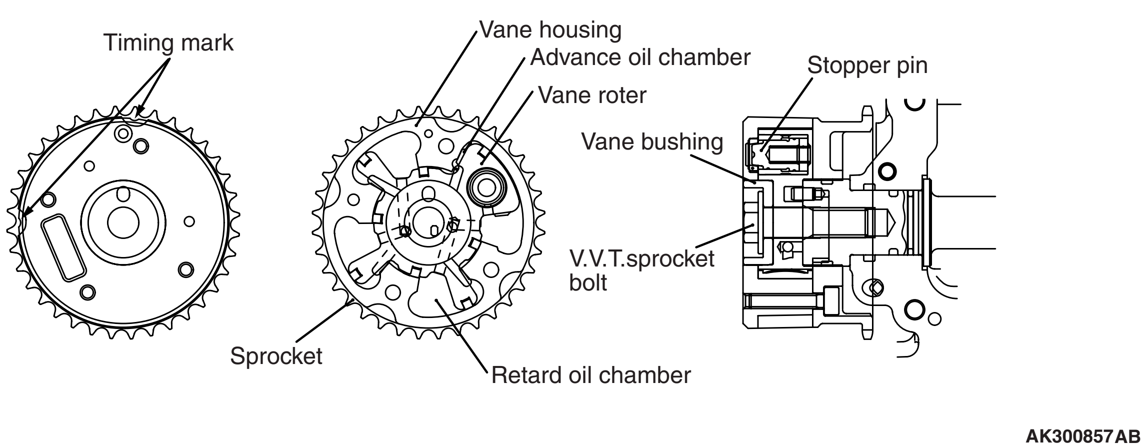
MIVEC (MITSUBISHI INNOVATIVE VALVE TIMING ELECTRONIC CONTROL SYSTEM)



MIVEC (Mitsubishi Innovative Valve timing Electronic Control system) consists of the components illustrated above.

The intake valve timing is optimally controlled (continuously variable) under the changing driving conditions to improve power in the entire speed range.

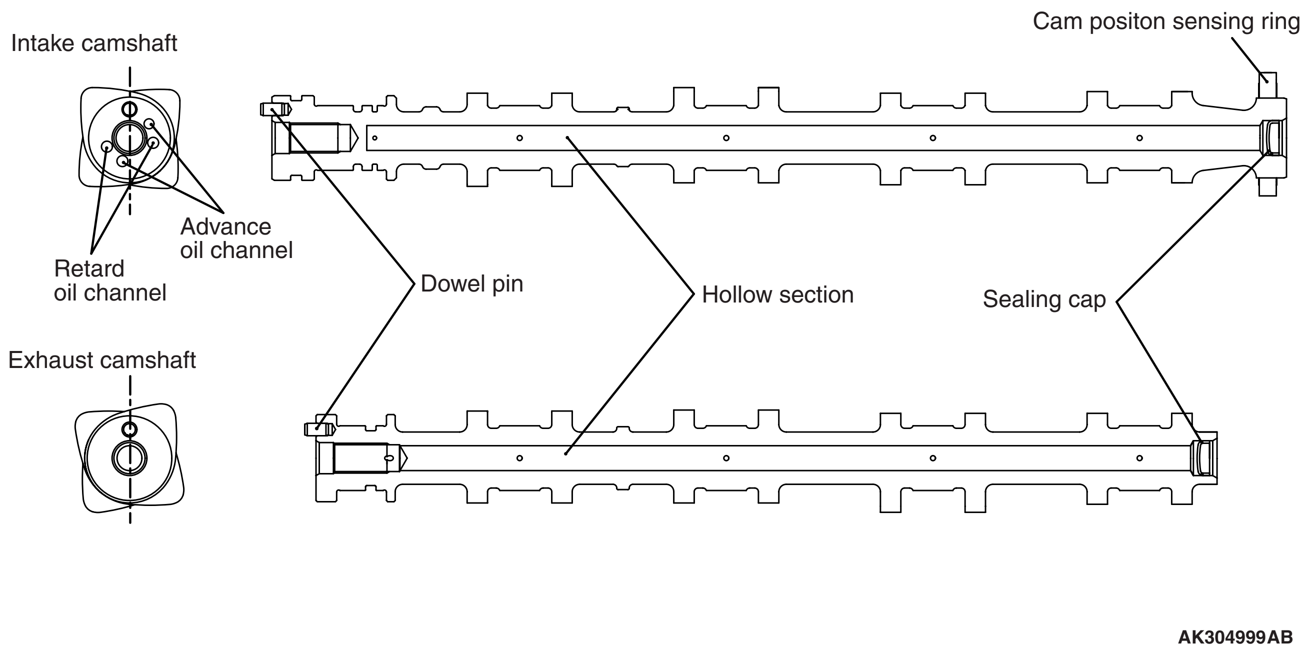
V.V.T. SPROCKET (VARIABLE VALVE TIMING SPROCKET)



Oil from the oil feeder control valve is sent to the V.V.T. sprocket, moving the vane rotor and thus regulating the valve timing.

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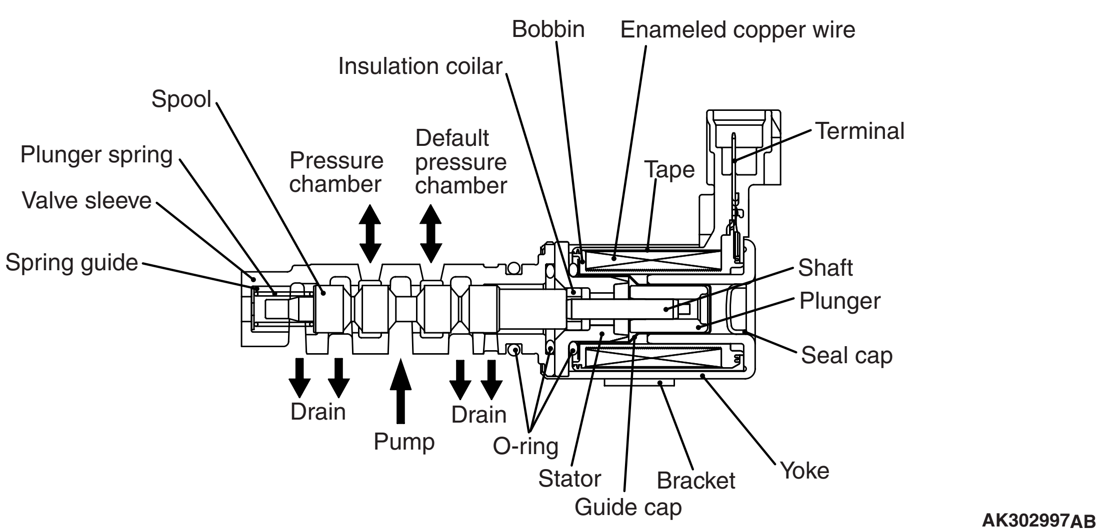
CAMSHAFT



The lightweight camshaft is achieved by the hollow design.
Oil channels run through the intake camshaft, through which oil is sent from the oil feeder control valve to the V.V.T. sprocket.
A cam position sensing ring is press-fitted onto the rear portion of the intake camshaft.

Item		Dimension
Overall length mm	Intake	407.5
	Exhaust	361.9
Journal mm		26
Valve lift mm	Intake	8.4
	Exhaust	7.9

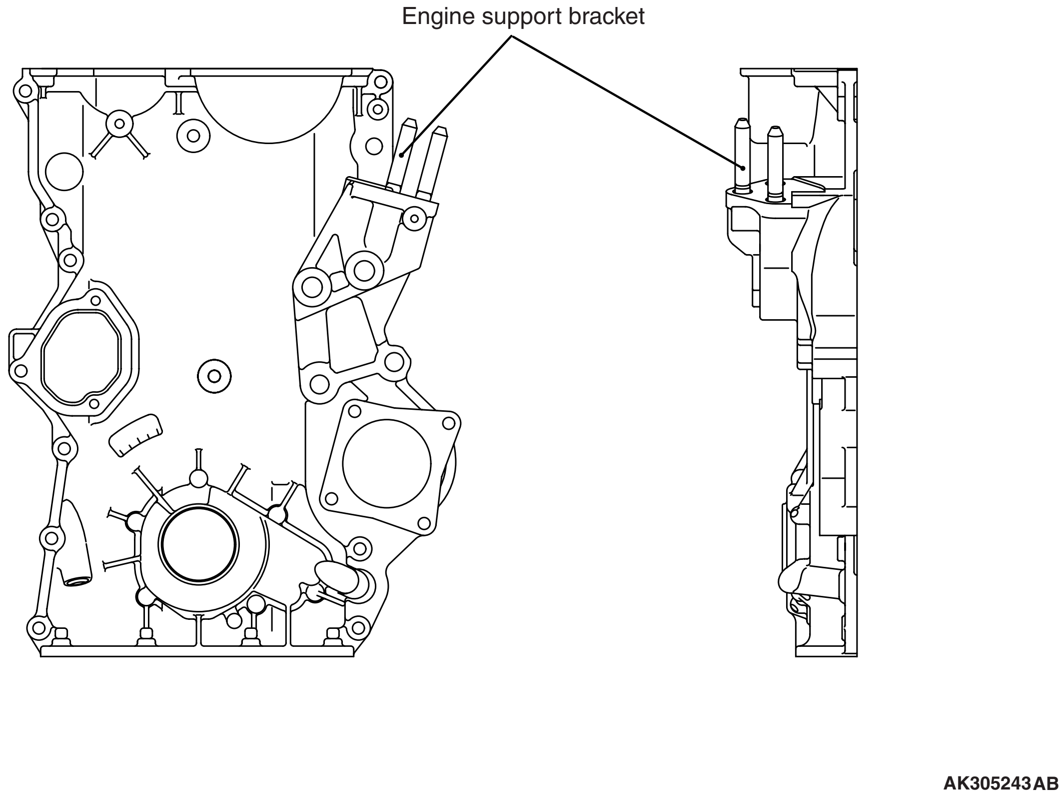
OIL FEEDER CONTROL VALVE(OCV)



The oil feeder control valve is essentially a solenoid valve, regulated by the engine-ECU or engine-A-M/T-ECU signals to feed oil to the V.V.T. sprocket assembly to move the vane rotor.

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TIMING CHAIN CASE



The engine support bracket, the oil pump and the relief valve are integrated as well as water chamber of the water pump.

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GENERAL INFORMATION

M2112000101009

The newly developed 1.5L 4A91 engine features 4-cylinder, 16-valve, and double overhead camshafts (DOHC).

The engine has the following features.

- Aluminum cylinder block
- MIVEC (Mitsubishi Innovative Valve timing Electronic Control system)
- Selective valve tappet of direct acting valve system for valve clearance adjustment
- Timing chain

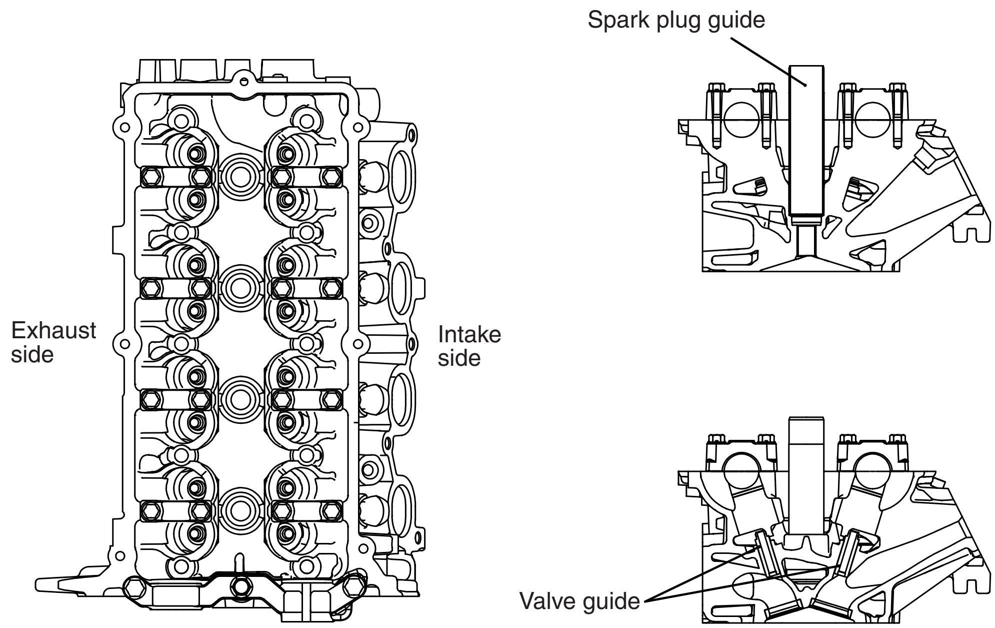
MAJOR SPECIFICATIONS

Item		**4A91**
Total displacement mL		1,499
Bore × Stroke mm		75 × 84.8
Compression ratio		10.0
Compression chamber		Pentroof-type
Valve timing	Intake opening	BTDC 31° – ATDC 19°
	Intake closing	ABDC 21° – ABDC 71°
	Exhaust opening	BBDC 39°
	Exhaust closing	ATDC 5°
Maximum output kW (PS)/rpm		77 (104)/6,000
Maximum torque N·m (kg·m)/rpm		141 (14.4)/4,000
Fuel system		Electronically controlled multipoint fuel injection
Ignition system		Electronic-controlled 4-coil

BASE ENGINE

M2112001000875

CYLINDER HEAD

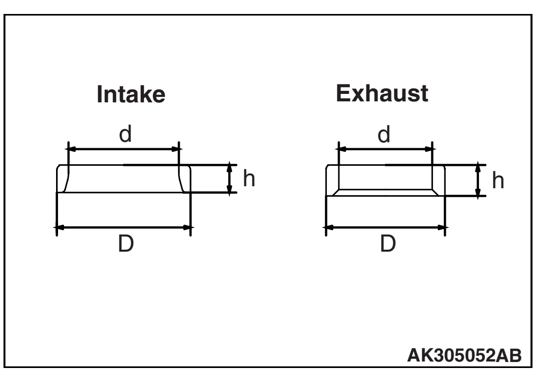


AK305050AB

The cylinder head is made of aluminum alloy, which is lightweight and has an excellent cooling efficiency. The pentroof type combustion chamber has a spark plug in the center. The valve angle is relatively small, contributing to size reduction.
The intake and exhaust ports are arranged in a cross-flow construction. Each cylinder has a pair of intake ports on one side and a pair of exhaust ports on the other side.

Each of the intake and exhaust camshafts is supported by 5 bearings. On each camshaft, the thrust load is supported by No. 1 bearing. The No. 1 bearings for the intake and exhaust camshafts have a common bearing cap.

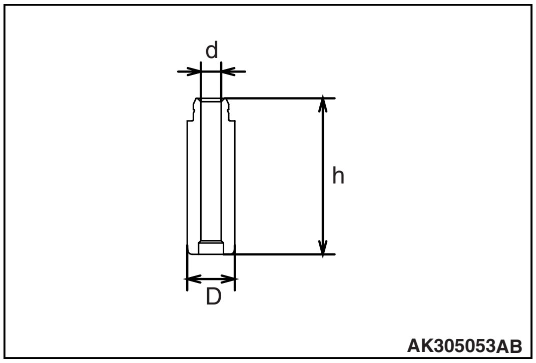
VALVE SEAT



Sintered alloy valve seat

Item	Intake	Exhaust
D (Outer diameter) mm	31.5	28
d (Inner diameter) mm	26	22
h (height) mm	6.6	7.3

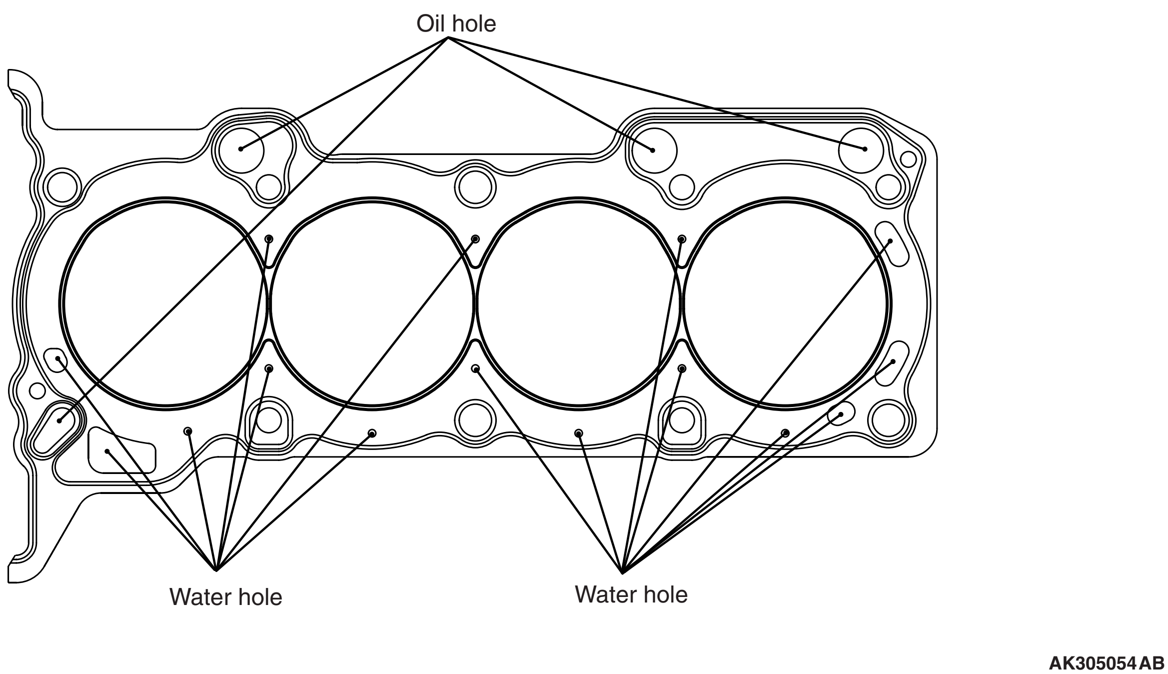
VALVE GUIDE



The intake and exhaust valves use the same-design valve guide.

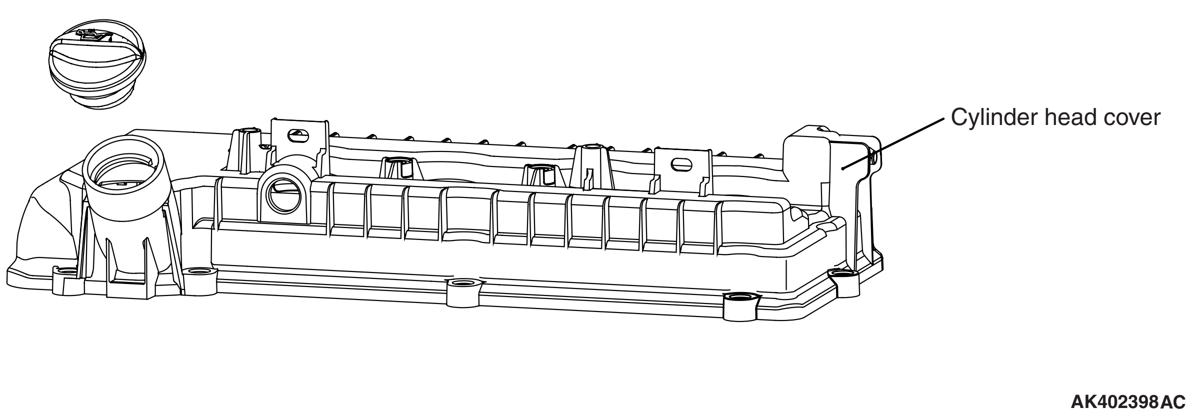
Item	Intake
D (Outer diameter) mm	10.5
d (Inner diameter) mm	4.5
h (height) mm	34.5

CYLINDER HEAD GASKET



The metal gasket having heat resistance, sealability and low cost is used for the cylinder head gasket.

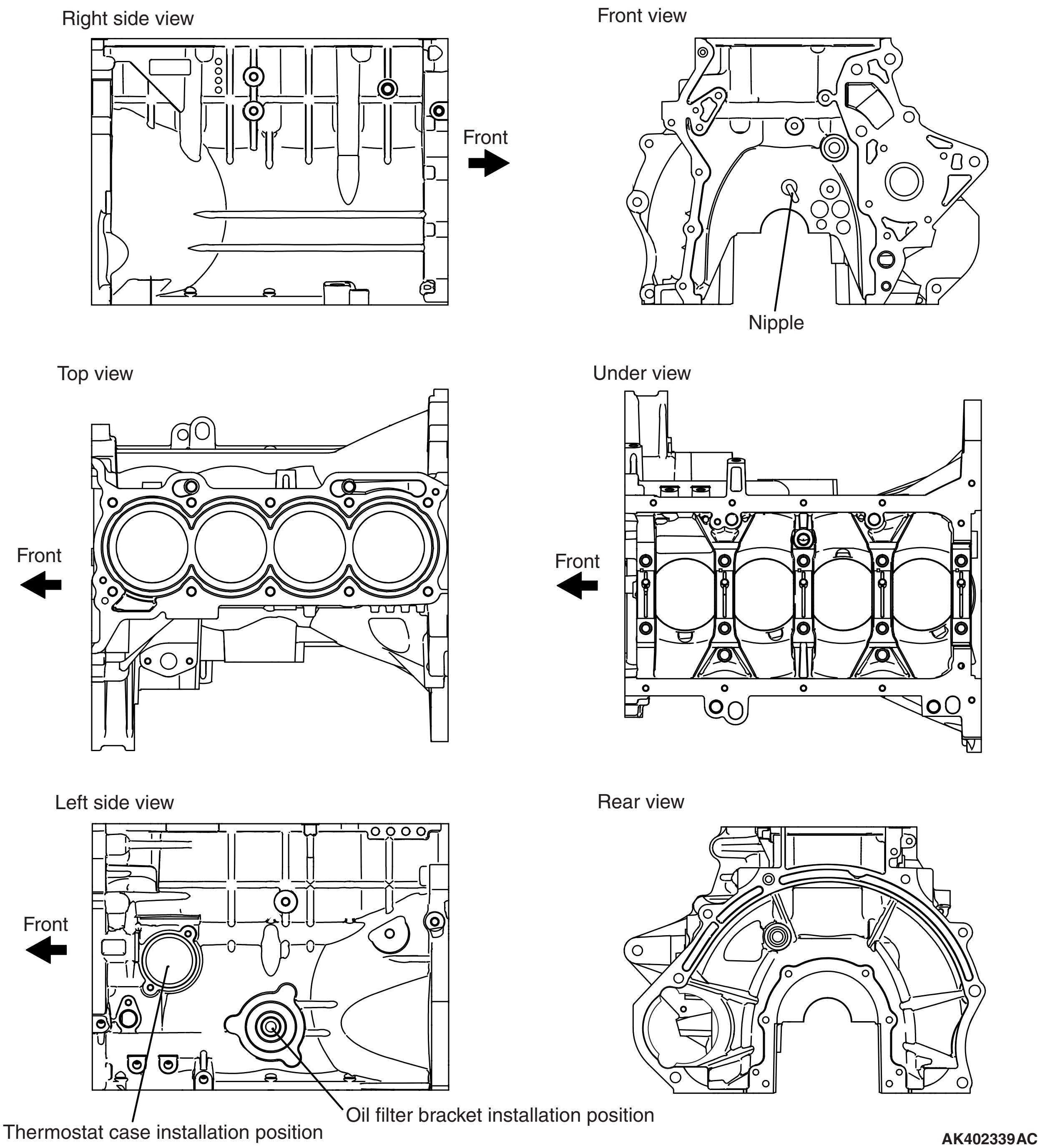
CYLINDER HEAD COVER



A resin cylinder head cover is used for the cylinder head.

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CYLINDER BLOCK

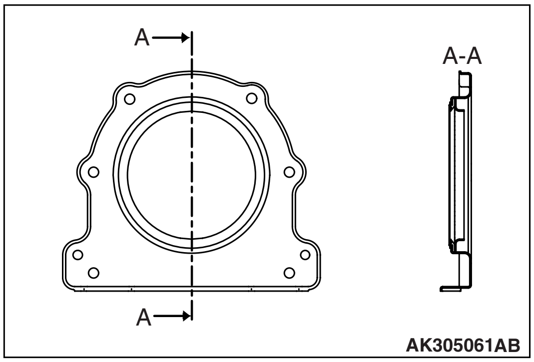


AK402339AC

The cylinder block is made of lightweight aluminum alloy.
The crankshaft journal is supported by 5 bearings.
The crankshaft thrust load is supported by No. 4 bearing.
The water jacket is of a full-siamese design.
A nipple is provided at the front of the block to supply engine oil onto the timing chain.

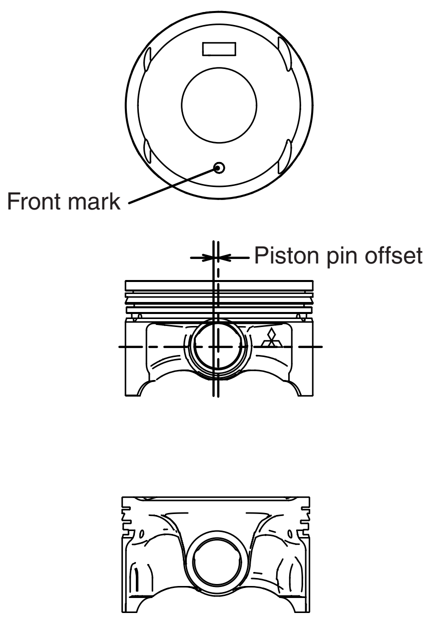
Item	Dimension
Overall height mm	280
Overall length mm	375.1
Top face to crankshaft center mm	205
Crankshaft center to bottom face mm	75
Bore mm	75
Bore pitch mm	83
Stroke mm	84.8

REAR OIL SEAL CASE



The rear oil seal case is a sheet-metal work. The case is installed with sealant applied onto the mounting face to prevent oil leakage.

PISTON

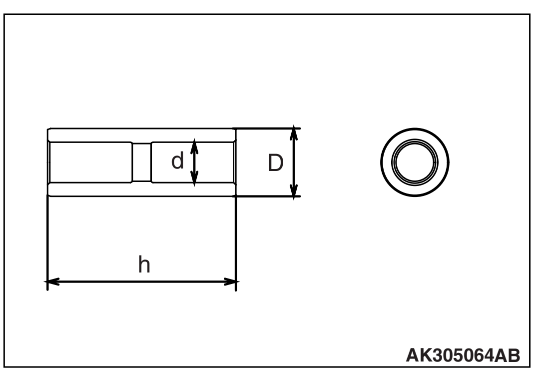


AK403222AB

The piston is made of special aluminum alloy. Weight reduction is achieved by minimizing the overall height while maximizing the recess on both ends of the piston pin.
The center of the piston pin hole is offset by 0.5 mm from the center of the piston towards the thrust side.
The piston skirt has a streak finish to enhance oil retention and anti-seizing property.

Item	Dimension
Base diameter mm	75
Pin diameter mm	18
Overall height mm	46.04

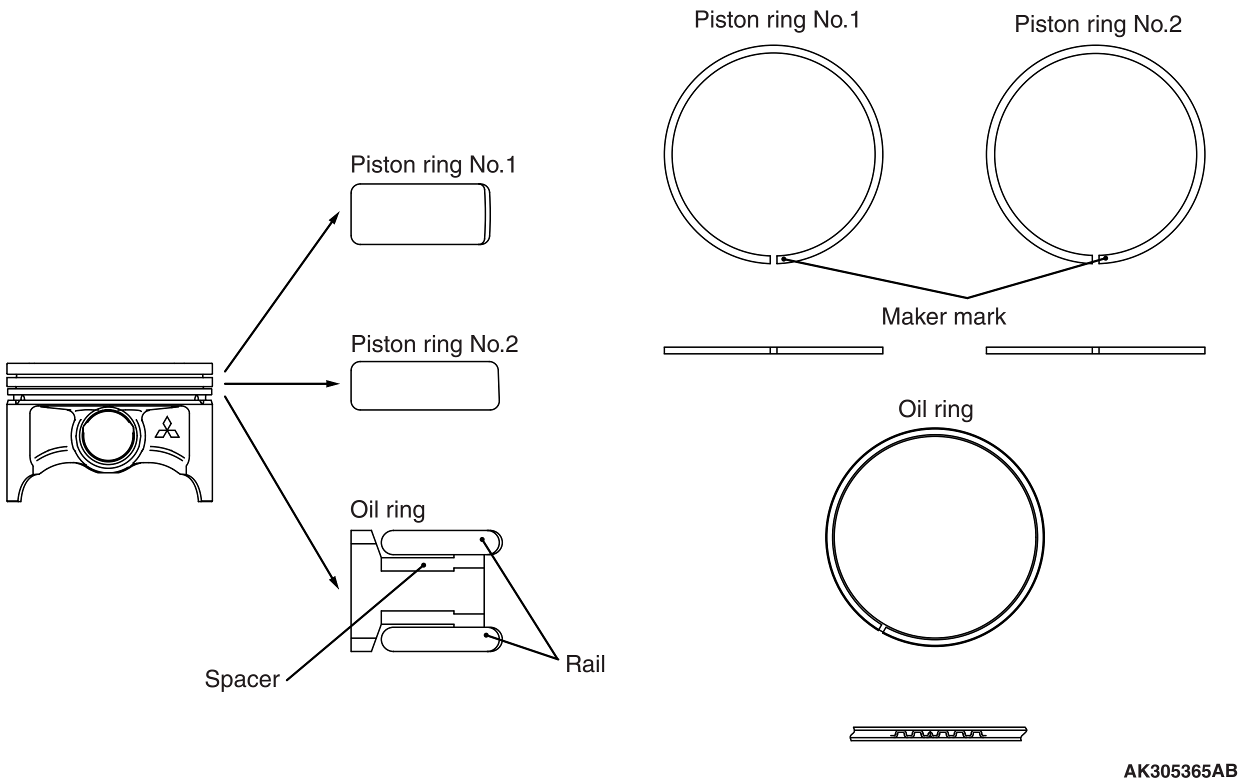
PISTON PIN



The piston pin is of a semi-floating type, press-fitted into the connecting rod small end while capable of floating relative to the piston.

Item	Dimension
D (Outer diameter) mm	18
d (Inner diameter) mm	11
h (Overall length) mm	50

PISTON RING

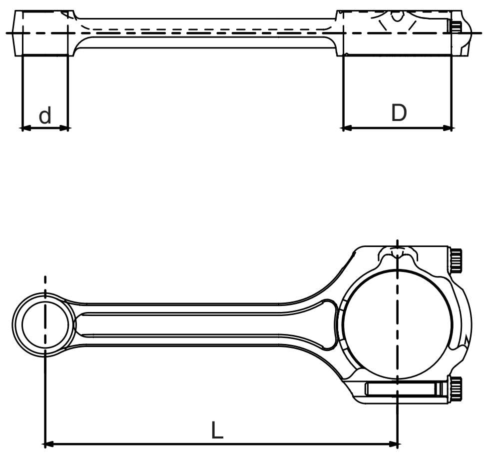


Each piston is provided with No. 1 and No. 2 compression rings and an oil ring.

Item	No. 1 piston ring	No. 2 piston ring	Oil ring
Shape	Barrel	Undercut	3-piece
Surface treatment (Contact face with cylinder)	Ion plating	Parkerized	Ion plating
Maker mark	No mafking	2R	No marking

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CONNECTING ROD

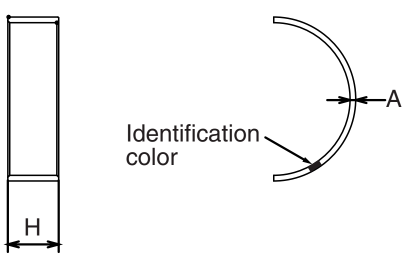


AK305065AB

The connecting rod is made of highly rigid, forged carbon steel. The rod portion has an H-shaped cross section.
The connecting rod big end bearing is lubricated through an oil passage running from the main journal to the crankshaft pin.

Item	Dimension
d (Small end inner diameter) mm	18
D (Large end inner diameter) mm	43
L (Center distance) mm	135.6

CONNECTING ROD BEARING



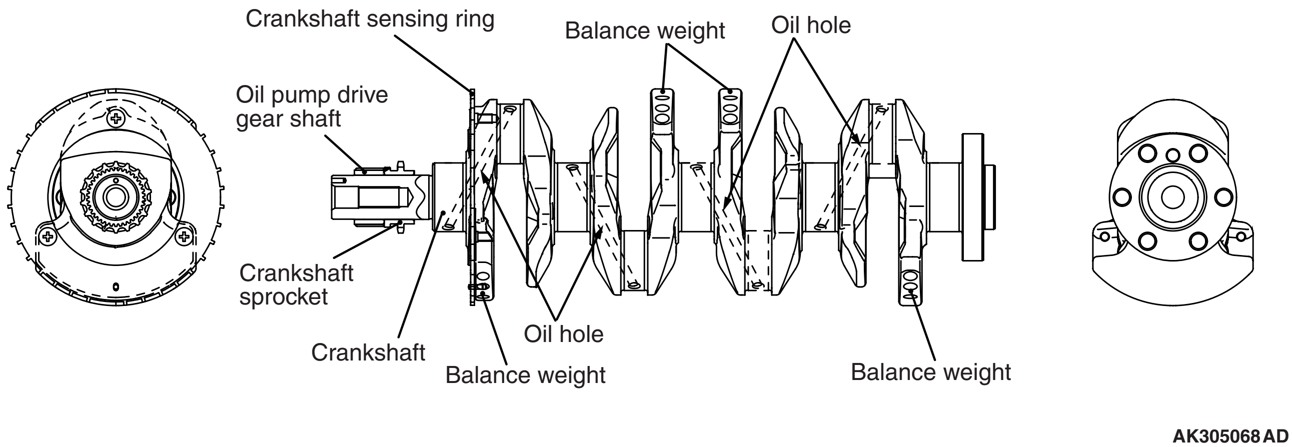
AK305309AB

The upper and lower connecting rod bearing halves are identical.
The connecting rod bearing is equipped with back metal. While the bearing itself is made of aluminum alloy, the back metal is normally made of steel sheet.
The connecting rod bearing is narrower than the bearing cap, this is to minimize wear.

Item	Dimension
H (Width) mm	13.5
A (Thickness) mm	1.5

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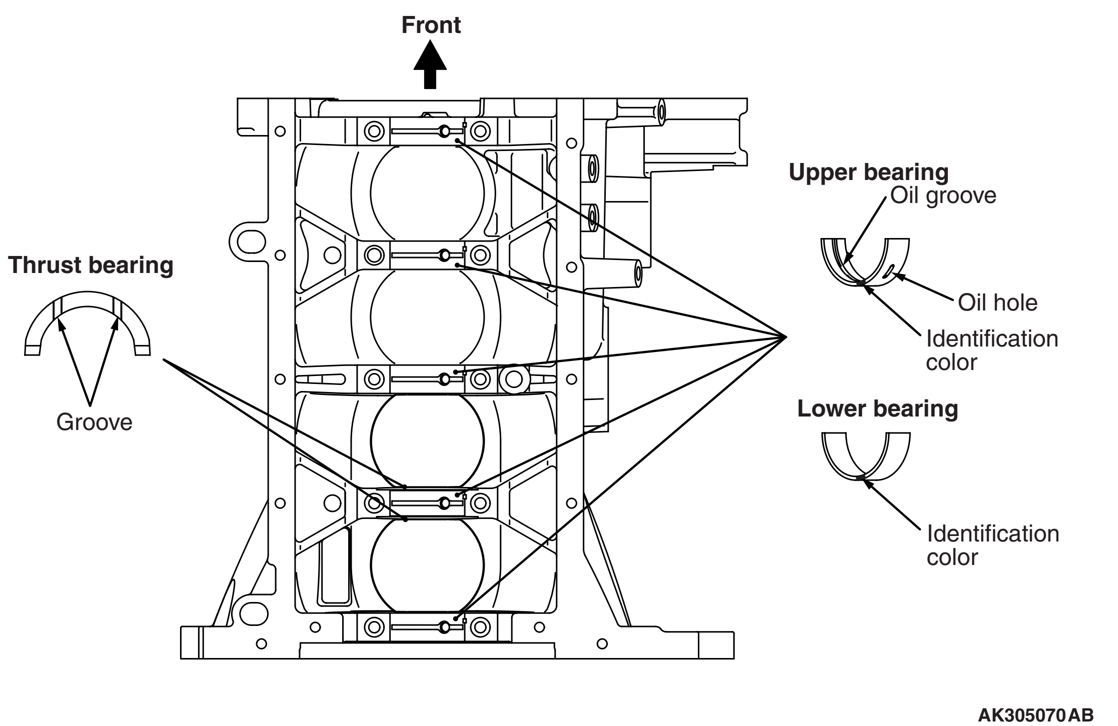
CRANKSHAFT



A casted crankshaft is used for the crankshaft. The crankshaft consists of 5 main bearings and 8 balance weights.
The crankshaft pins are arranged at 180° intervals.
The oil hole supply lubrication oil from the journal to the crank pin.

A crankshaft sprocket and an oil pump drive gear shaft are press-fitted onto the front of the crankshaft. The crankshaft is also fitted with a crankshaft sensing ring.

CRANKSHAFT BEARING, THRUST BEARING



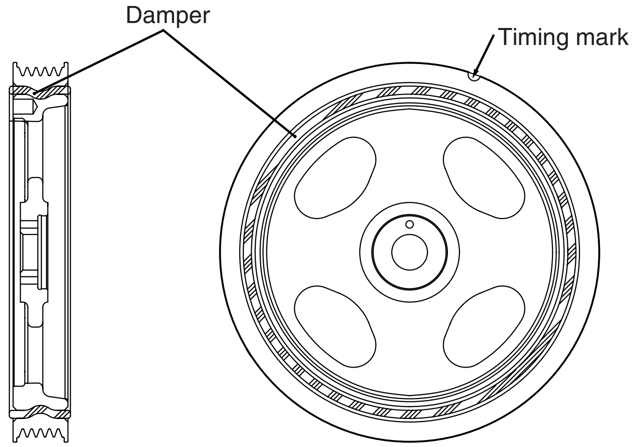
The upper crankshaft bearing (with oil groove) is located on the cylinder block side while the lower bearing (without oil groove) is held by the bearing cap.
The crankshaft bearing is equipped with back metal. While the bearing itself is made of aluminum alloy, the back metal is normally made of steel sheet.

A thrust bearing is installed on both sides of the No. 4 crankshaft bearing.

Item		Dimension
Crankshaft bearing	Width mm	16
	Thickness mm	20
Crankshaft thrust bearing	Thickness mm	3.275

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CRANKSHAFT PULLEY

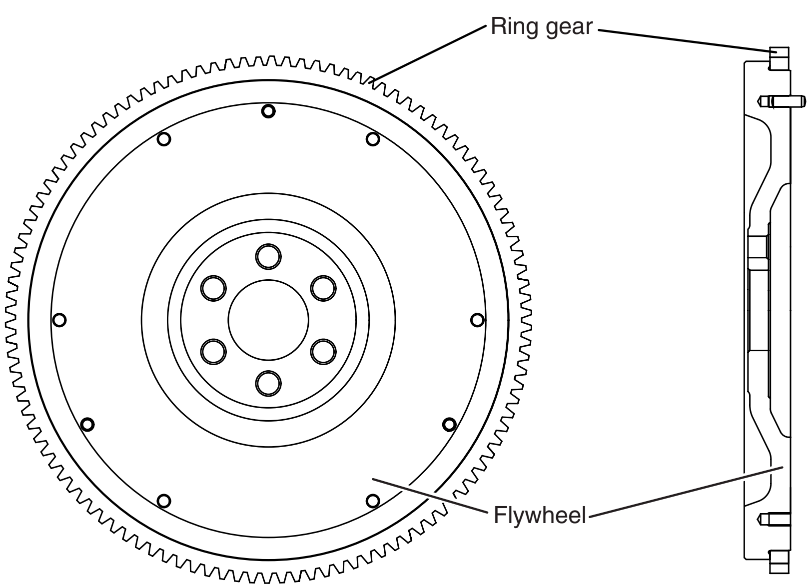


AK305072 AD

A cast iron crankshaft pulley is used.
The pulley has grooves to engage with a V-ribbed belt (5 ribs), which drives an alternator and a water pump.
An ignition timing mark (notch) is stamped on the flange of the pulley.

The crankshaft pulley is equipped with a torsional damper to minimize the torsional vibration of the crankshaft as well as substantially reduce noise and vibration at the high speed range.

Flywheel

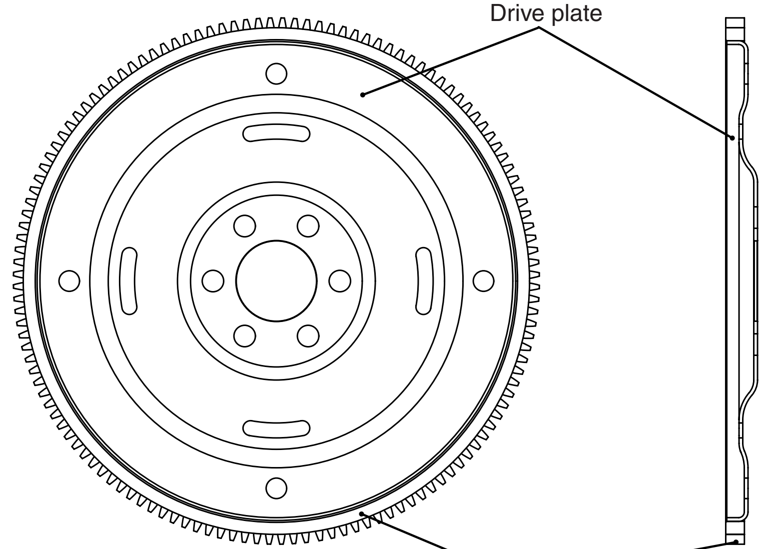


AK600531 AB

A cast iron ring gear is a shrink fit in the iron casting of the flywheel. The flywheel is installed by tightening six bolts.

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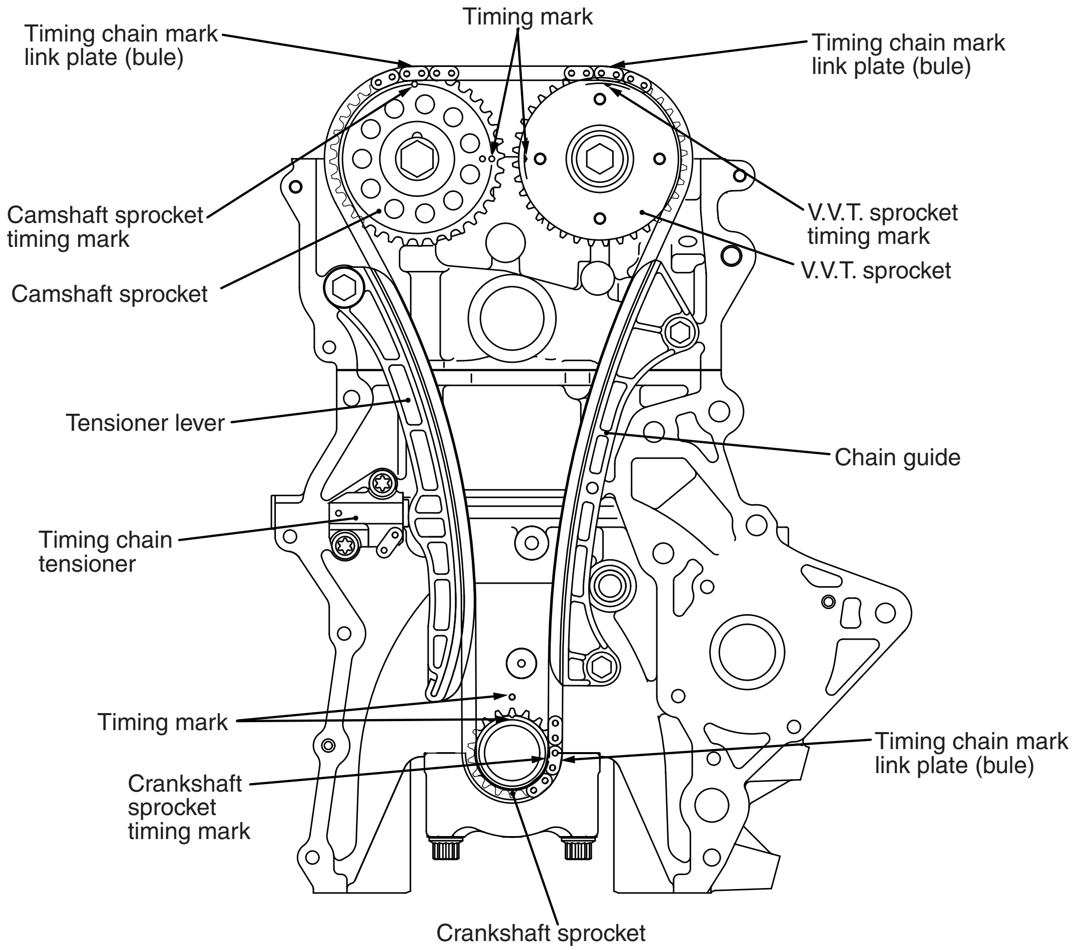
DRIVE PLATE



A cast iron ring gear is a shrink fit in the steel plate of the drive plate. The drive plate is installed by tightening six bolts.

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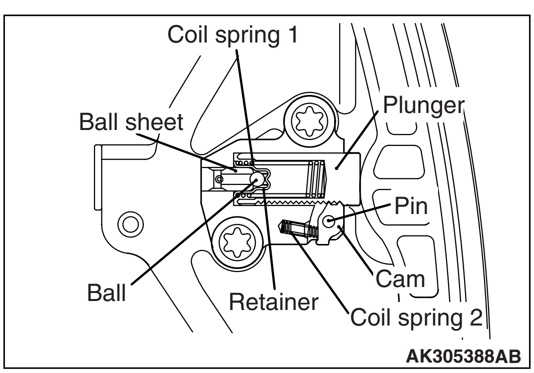
TIMING CHAIN TRAIN



The 2 camshafts are driven by the timing chain via the respective sprockets.
The timing chain, consisting of 122 links, is an endless chain, connecting the crankshaft sprocket with the camshaft and V.V.T. sprockets.
The timing chain is equipped with 3 mark link plates (blue) to correctly time the 3 sprockets with each other.

Item	No. of teeth
Camshaft sprocket	36
V.V.T. sprocket	36
Crankshaft sprocket	18

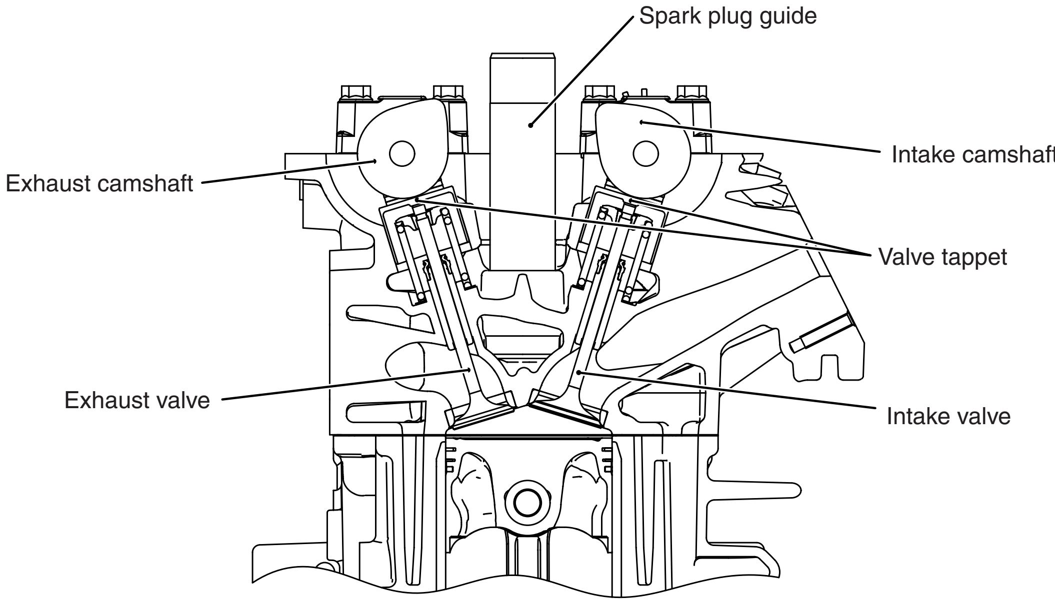
TIMING CHAIN TENSIONER



The timing chain is tensioned by the timing chain tensioner, which has a built-in plunger with plunger springs.
The plunger in the timing chain tensioner directly pushes the tension lever, and the pressure automatically adjusts the timing chain tension.
A cam is provided to lock the plunger in place after the engine stops. This helps prevent the timing chain from wobbling just after the engine starts.
With the timing chain tensioner installed, do not crank the engine in the reverse direction. This will force the plunger to overcome the cam, or even cause other problems.

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VALVE MECHANISM

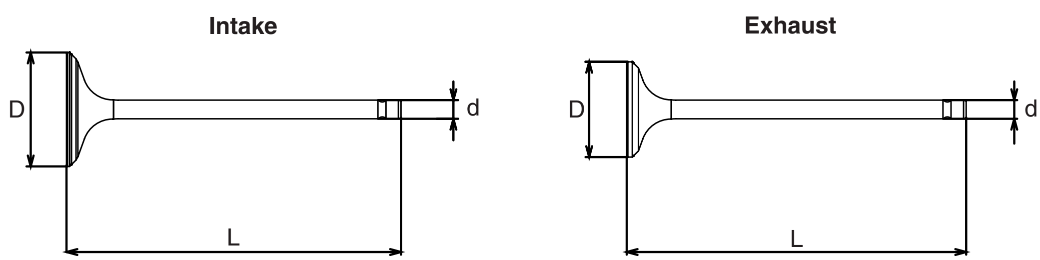


AK305076AB

The valve mechanism is based on a 4-valve DOHC (Double Over Head Camshaft) design having the camshaft on the upper valve. Each cylinder has 2 intake valves and 2 exhaust valves, arranged in a V-shape pattern.

Camshaft rotation is transmitted via valve tappets to the respective valves which open and close accordingly.

VALVE



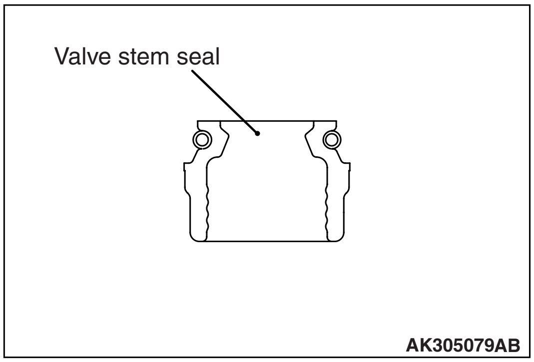
AK305078AB

The valves have heat-resistance. The entire valve surface is treated with gas nitriding.

Item	Intake valve	Exhaust valve
Head diameter mm	30.5	25.5
Stem diameter mm	5.0	5.0
Overall length mm	89.61	90.94

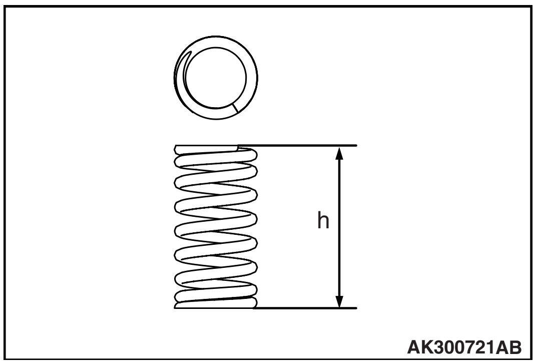
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VALVE STEM SEAL



The valve stem seal employs springs to enhance sealing performance, minimizing oil passing down to the port.

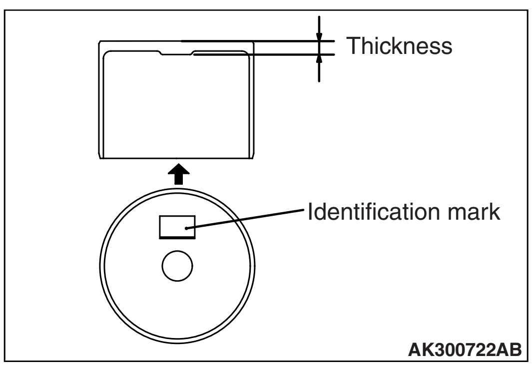
VALVE SPRING



The valve spring has a dual pitch spring to prevent surging in the high speed range.

Item	Specification
Free length mm	43.1
No. of spring turns	8.49

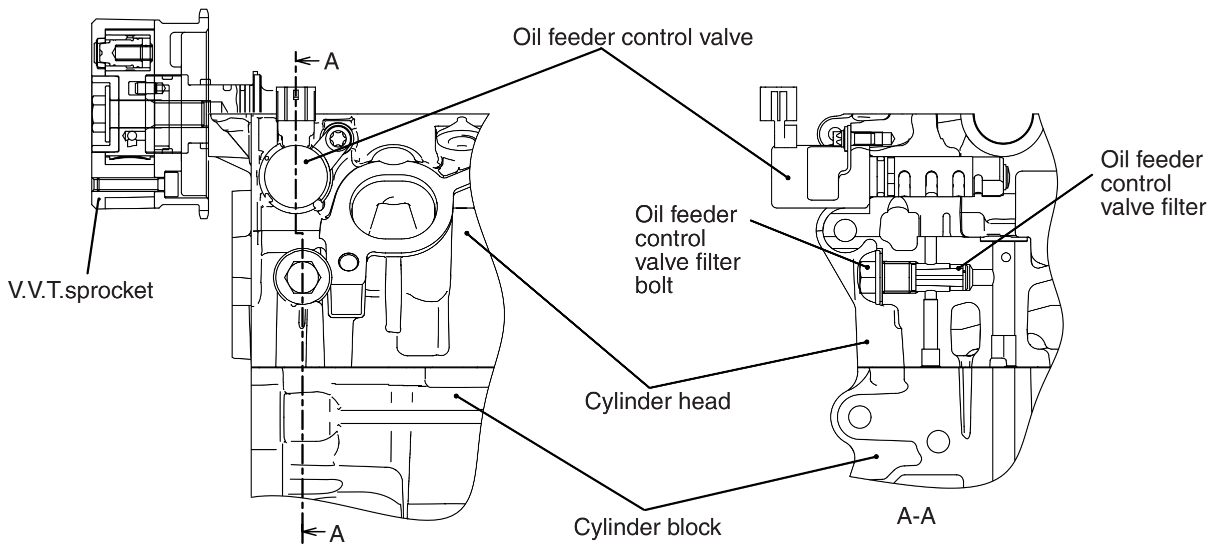
VALVE TAPPET



Valve tappets are available in 31 thicknesses, at 0.02 mm intervals between 2.70 mm and 3.30 mm, to ensure correct valve clearance.

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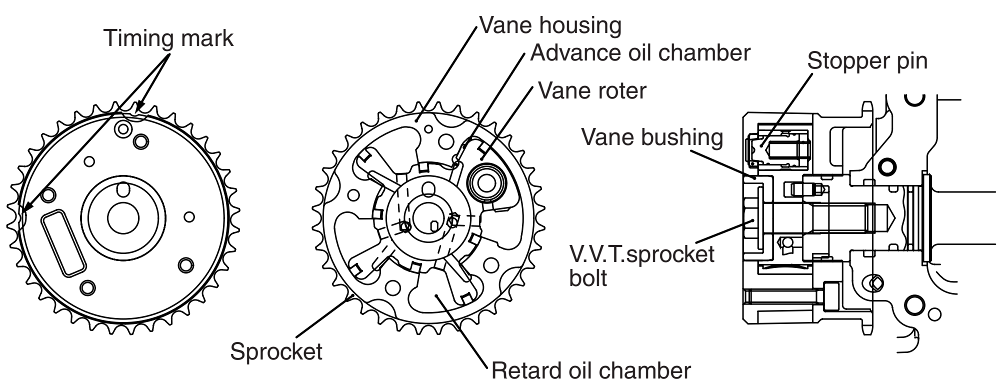
MIVEC (MITSUBISHI INNOVATIVE VALVE TIMING ELECTRONIC CONTROL SYSTEM)



MIVEC (Mitsubishi Innovative Valve timing Electronic Control system) consists of the components illustrated above.

The intake valve timing is optimally controlled (continuously variable) under the changing driving conditions to improve power in the entire speed range.

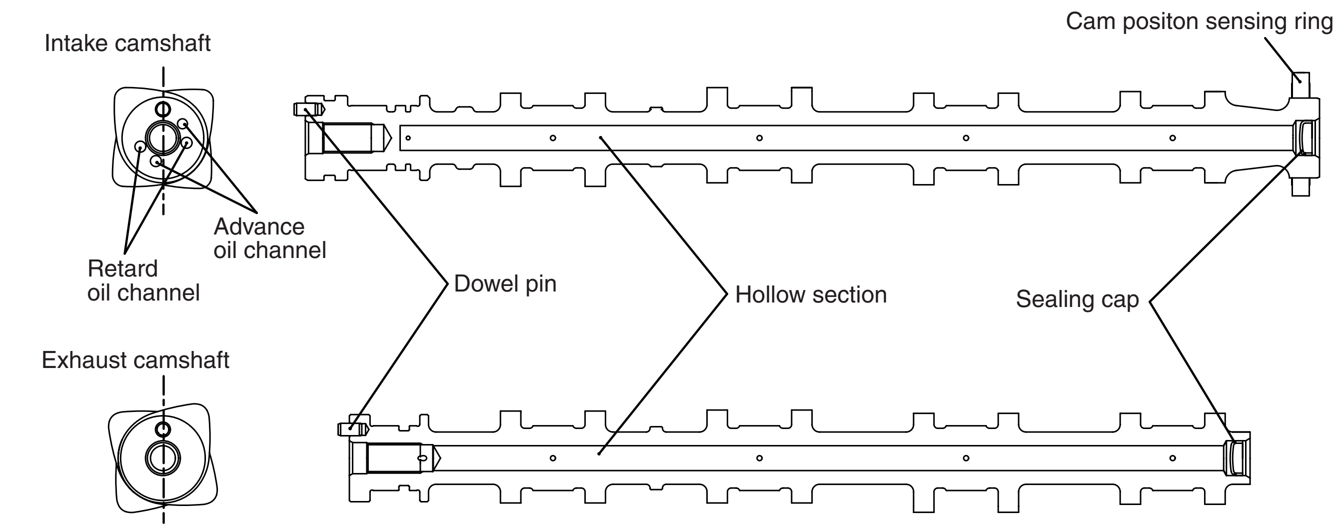
V.V.T. SPROCKET (VARIABLE VALVE TIMING SPROCKET)



Oil from the oil feeder control valve is sent to the V.V.T. sprocket, moving the vane rotor and thus regulating the valve timing.

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CAMSHAFT

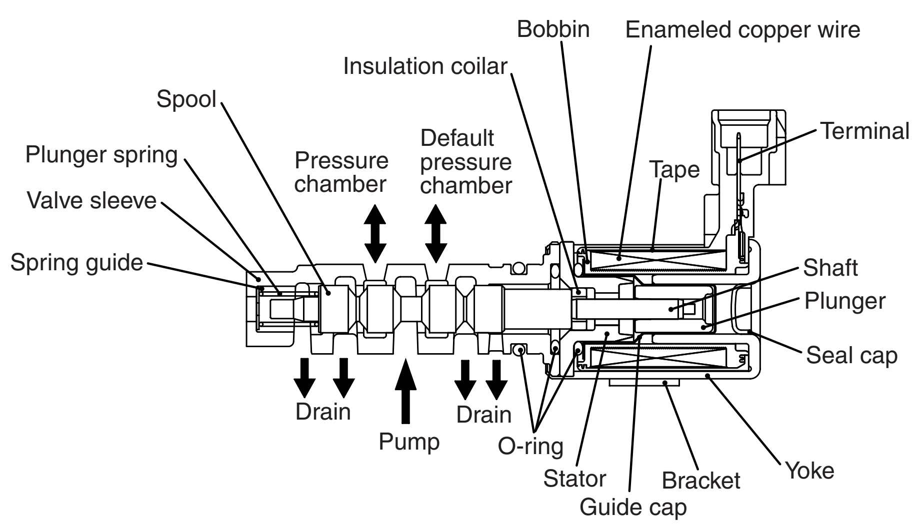


AK304999AB

The lightweight camshaft is achieved by the hollow design.
Oil channels run through the intake camshaft, through which oil is sent from the oil feeder control valve to the V.V.T. sprocket.
A cam position sensing ring is press-fitted onto the rear portion of the intake camshaft.

Item		Dimension
Overall length mm	Intake	407.5
	Exhaust	361.9
Journal mm		26
Valve lift mm	Intake	8.4
	Exhaust	7.9

OIL FEEDER CONTROL VALVE(OCV)

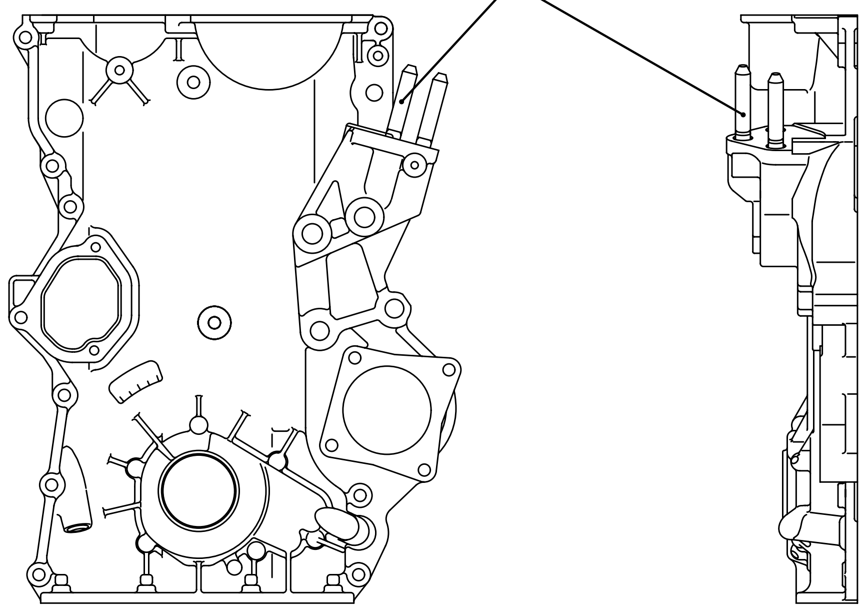


AK302997AB

The oil feeder control valve is essentially a solenoid valve, regulated by the engine-ECU or engine-A-M/T-ECU signals to feed oil to the V.V.T. sprocket assembly to move the vane rotor.

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TIMING CHAIN CASE



AK305243AB

The engine support bracket, the oil pump and the relief valve are integrated as well as water chamber of the water pump.